

COMBATING HEALTH MISINFORMATION THROUGH PUBLIC SERVICE ANNOUNCEMENTS: EVALUATING COUNTER-NARRATIVE STRATEGIES AMONG HEALTHCARE CONSUMERS

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Abstract

The proliferation of health misinformation presents an urgent challenge to public health initiatives. Although PSAs are utilized mainly to convey health while public service announcements (PSAs) are commonly employed to address health misinterpretation, few studies have compared counter-narrative with strategies in tackling misinformation. This study investigates the effectiveness of three distinct counter-narrative approaches in healthcare PSAs—fact-checking, storytelling, and expert authority—in combating vaccine and medication misinformation. 422 adults across eight districts of Tripura participated in a mixed-methods experiment evaluating immediate and delayed responses to these approaches. Storytelling strategies showed effect over time (sustained 68% retention at 4-week follow-up), compared to initial high but rapidly diminishing impact of fact-checking approaches (42% retention). These findings provide evidence for developing context-specific PSA strategies to combat health misinformation, suggesting that healthcare communicators should implement integrated approaches combining narrative elements with authoritative sources and consider the temporal dimension when designing public health communication campaigns.

Keywords: Public Service Advertising, Public Service Announcements, Health, PSA, Misinformation, Counter-Narrative.

INTRODUCTION

The transmission of misinformation in health has increased the skepticism for vaccination among people in the remote North eastern part of India (**Aggarwal et al. 2024**). Public service announcement has been used commonly to share important health information and to promote health hygiene habits. Although with respect to rectifying the fake information it is still not clear how competently and accurately public service announcements (PSAs) operate.

(**Belobroukina and Rodgers 2023**) explains that it is not very compelling to share important health information to people who actually believe the false information to be true without attaching any inspirational message. Another study by (**Greene et al. 2022**) demonstrates that effective public service announcements (PSAs) depend on how effectively the message has been generated and advertised. We have found lack of

knowledge in identifying which sort of messages in healthcare public service announcements will be impactful to counter the misinformation specifically in a state like Tripura where there is amalgamation of people from different social and cultural backgrounds. **(Sivakumaran et al. 2023)** suggested that scrutinizing each misinformation and delivery and information through story telling are some of the distinctive methods. However, there are studies which thoroughly compare the methods to check which strategy works the best. Another study **(Jin et al. 2022)** explains that fake information stays for a longer time and public service announcements help rectifying the fake information but it is difficult to measure their long-lasting effects. Therefore, our study aims to feel the lack of knowledge by analyzing how different counter messages in the health public service announcements will affect people's perception and traditional beliefs. It also aims to investigate whether people cultivate information seeking habit and whether the adults develop healthy habits in Tripura. The study will also help to evaluate how fast these transformations occur and its lasting period. The result and findings of the research paper will be beneficial for health institutions professional s and government to establish an effective PSA that counter fake information and will motivate people to cultivate healthy habits.

LITERATURE REVIEW

Healthcare Misinformation: Prevalence and Impact

In this 21st century misinformation on health has peaked. **(Jin et al. 2022)** Stated that spread of misinformation regarding health with the help of misleading news and information have transformed into a universal threat. The similar study also reported that misinformation on polio vaccine has strategically helped in lowering the polio vaccine acceptance by 43% in some specific areas. Similarly, another study **(Habes et al. 2022)** exposed that throughout the time of COVID-19 pandemic, people found it inconvenient to emulate the safety regulations and guidelines which resulted in increase in the spread of virus and fear regarding the vaccination.

The concern with false health information is getting serious especially in areas where we have limited health care services and comparatively lower levels of literacy. **(Soorapanth et al. 2023)** exhibit how falsification of health information impact differently in urban and rural areas. **(Soorapanth et al. 2023)** indicates misleading health information affects urban and rural citizens in different ways. Furthermore, the study discovered that rural people more often fall for the trap of misleading or fake information. **(Greene et al. 2022)** suggested that general public's perception get confused when health related problems mix with politics. Further the study disclosed that it was difficult for the medical authorities and professionals to convey emergency messages (like wearing N95 masks) during the time of COVID-19 pandemic.

Altogether the studies confirm that misleading health information / statement are a real threat and is growing rapidly at a fast pace. Therefore, it displays how crucial it is to find innovative techniques to distribute trust worthy health and medical informatics with general citizens.

Public Service Announcements in Healthcare

For decades health campaigns relied on PSAs to communicate crucial health informatics.

(Sivakumaran et al. 2023) reviewed numerous PSA research studies and discovered that medical and health PSAs utilizes emotion like anxiety, panic, satire, comforting tones) to inspire general citizen to adapt healthy hygienic habits. The study further reveals that health-related PSAs work effectively in communicating mindful trustworthy information. However, it encounters several hurdles / challenges in inspiring the general citizens to adapt the healthy hygienic habits. **(Alptekin et al. 2024)** carried on an ingenious study to investigate on how the brain and body reacts to check how well the covid-19 PSAs worked. The study also revealed that if PSAs are being conveyed with an impactful sentimental message it creates an impression in the minds of the general audience more than the PSAs that are only rational and based on facts. Such sentimental messages also help in grabbing audience's attention more easily. Thus, this study conveys/explain how sentimental involvement plays an important part in PSAs to grab attention of the audiences and to recollect the message back. **(Baraybar Fernández, Baños González, and Rajas Fernández 2023)** expanded the study further to observe how memory and sentiments are linked with each other pertaining to watching health related PSAs with the help of cognitive neuroscience. The study also explains that audience's reactions and responses depend on the messages conveyed on the PSAs in health. Thus, suggesting the importance of planning PSAs separately for different individuals. Even though we get to learn a lot about how effectively we can convey message through PSAs but there is still exist huge gap in research when it comes to tackle the false information / fake information with the help of PSAs directly. **(Tait et al. 2022)** examined that a numerous PSAs on COVID-19 pandemic were unsuccessful in blocking the fake information. However, they recommended designing PSAs in health that will tackle the fake information directly.

Counter-narrative Strategies in Health Communication

As fake news spreads faster than trustworthy information research scholars across the globe has done some innovative and emerging study where they have developed strategies to tackle the fake news with some effective and emotion driven messages. **(Looi, Kemp, and song 2023)** investigated how the contents of social media influencers on Instagram helped general people to motivate to avoid with the covid-19 safety protocols. Furthermore, the study indicates that messages which were more inclined towards local community were impactful. Therefore, it can be an effective strategy to block and tackle the fake information. **(Alhabash et al. 2022)** examined weather emotions (like fear and joy) driven messages on PSAs perform excellent in resisting general public from purchasing risky medicine (drugs) online. Keeping the entire hypothesis aside, the study discovered that health messages in PSAs makes better impact if delivered with satire and humor and closely minimizes the general public's attraction towards perilous or risky drug. **(Chen et al. 2024)** underlined that to make fear-based PSAs impactful they should portray how dangerous and hazardous it is and recommend clear guidance on what to do.

Temporal Aspects of Misinformation Correction

(Reinhardt, Rossmann, and Engel 2022) investigated vaccination ads for senior citizens and found that messages that underline aid and advantage grabs more attention initially but gradually the impact fades over the period.

The objective of the study was to underline the effect of health-related messages. The study also highlighted the fact that messages related to health should not be evaluated / examined only for immediate reaction but also for a strong long-lasting impact. (Fu et al. 2022) utilized brain scans to figure out how audiences subliminally respond to PSAs. The study observed that is certain section of the brain reacts to the advertisements. Thus, proves how impactful the advertisements were.

The study recommends that monitoring the neuro-activities will assist in anticipating the duration of PSAs impact particularly when tackling fake information. Maximum studies investigated audience's immediate reaction to the health messages on PSAs. But it lacks knowledge on the long-lasting effect of the messages.

Conceptual Framework Development

After thoroughly reviewing the existing literature, we have produced a structured model that assembles several independent strategies for message delivery and their long-lasting impact to counter fake information on health. Our framework extracts the concept, Idea and design from three main theories: the elaboration likelihood model (Petty and Cacioppo 1986), the extended parallel process model (Witte 1992) and the narrative transportation theory (Green and Brock 2000). These theories illustrate how people perceive a message and respond to it rationally or emotionally.

Our strategic model or framework explain that the impact of a message depends on what sort of method has been used? What sort of fake information or misinformation it is tackling? And whether the impact last for a longer period of time or not? These messages depend on two things (i) what are the orthodox belief of the people? And (ii) how tech-savvy they are? It also relies upon location (where they live) & kind of information they regularly seek.

The framework posits that different counter-narrative approaches engage different cognitive and affective processing pathways, with fact-checking primarily engaging analytical processing, storytelling activating emotional and experiential processing, and expert authority appeals leveraging heuristic processing.

These methods are applied by people to process the information. But sometimes it may function diversely at an initial stage and as time goes on depending on individual characteristics and situation.

This strategic model and framework assist our methodology and hypothesis for research by providing a standardized approach to analyze and understand the intricate exchange between the story telling strategies, short- & long-lasting effect and situational factors to tackle the fake information regarding healthcare.

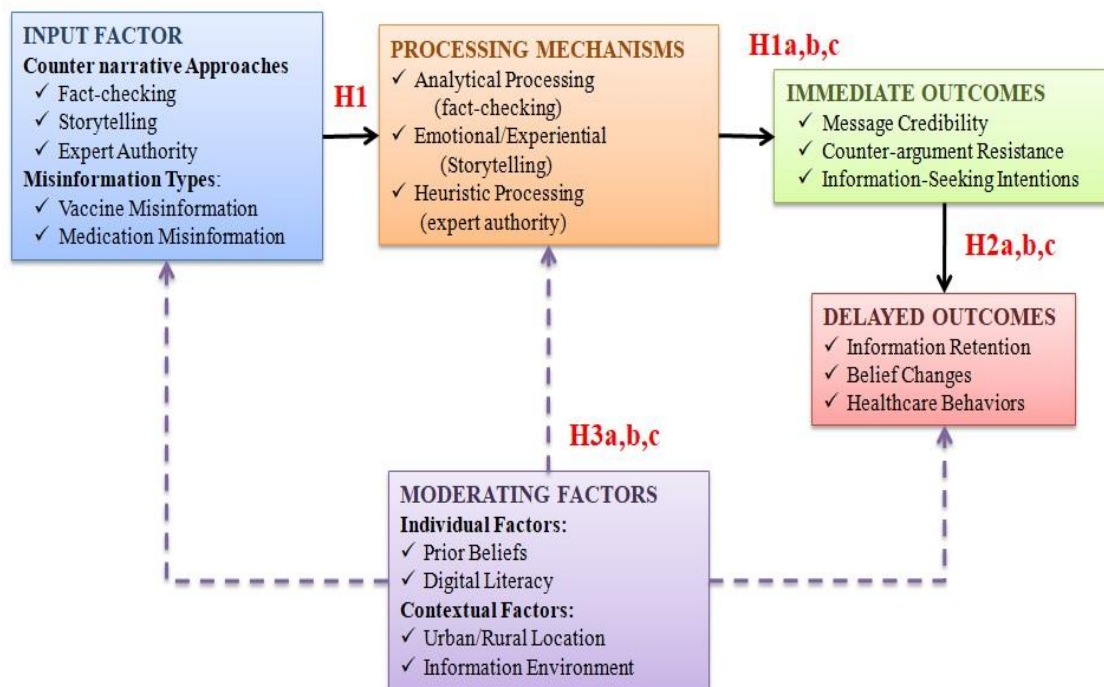
RESEARCH OBJECTIVES

After thoroughly reviewing the past literature and the existing gap in knowledge our research sets out to address the following objectives:

1. To evaluate the differential effectiveness of three counter-narrative strategies in healthcare PSAs (fact-checking, storytelling, and expert authority) in neutralizing vaccine and medication misinformation among adults in Tripura.
2. To assess how these counter-narrative strategies impact immediate outcomes (message credibility, counter-argument resistance, and information-seeking intentions) and delayed outcomes (information retention, belief changes, and healthcare behaviours).
3. To investigate how individual factors (prior beliefs, digital literacy) and contextual factors (urban/rural setting, information environment) moderate the relationship between counter-narrative strategies and their effectiveness in combating health misinformation.

CONCEPTUAL FRAMEWORK

CONCEPTUAL FRAMEWORK FOR COUNTER NARRATIVE STRATEGIES IN STRATEGIES IN HEALTHCARE PSAs



THEORETICAL FOUNDATION: Elaboration Likelihood Model, Narrative Transportation Theory, Extended Parallel Process Model

Fig 1: Conceptual Framework

The conceptual framework for this study integrates three theoretical perspectives—the Elaboration Likelihood Model, the Extended Parallel Process Model, and the Narrative Transportation Theory—to understand how different counter-narrative strategies in healthcare PSAs affect misinformation correction over time.

The framework illustrates the relationships between:

1. Input Factors:

- Counter-narrative approaches (fact-checking, storytelling, expert authority)
- Misinformation types (vaccine, medication)
- Individual characteristics (prior beliefs, digital literacy, demographic factors)
- Contextual factors (urban/rural setting, information environment)

2. Processing Mechanisms:

- Analytical processing (primarily engaged by fact-checking)
- Emotional/experiential processing (primarily engaged by storytelling)
- Heuristic processing (primarily engaged by expert authority)

3. Immediate Outcomes:

- Message credibility
- Counter-argument resistance
- Information-seeking intentions

4. Delayed Outcomes:

- Information retention
- Belief changes
- Healthcare behaviours

The framework posits that different counter-narrative approaches activate different processing mechanisms, which in turn produce varying patterns of immediate and delayed outcomes.

These relationships are moderated by individual characteristics and contextual factors, creating complex interaction effects that determine the overall effectiveness of healthcare PSAs in combating misinformation.

This conceptual framework guides our hypotheses and methodological approach, providing a structured way to understand the multi-faceted nature of healthcare misinformation correction.

HYPOTHESES

Based on the conceptual framework and literature review, the following hypotheses are proposed:

- H1: Counter-narrative strategies in healthcare PSAs will show differential effectiveness in neutralizing health misinformation, with:
 - H1a: Storytelling approaches demonstrating higher counter-argument resistance than fact-checking approaches.
 - H1b: Expert authority approaches showing higher immediate message credibility than both storytelling and fact-checking approaches.
 - H1c: Fact-checking approaches generating higher immediate information-seeking intentions than storytelling approaches.
- H2: The effectiveness of counter-narrative strategies will vary over time, with:
 - H2a: Storytelling approaches maintaining effectiveness better than fact-checking approaches at 4-week follow-up.
 - H2b: Expert authority approaches showing moderate decay in effectiveness over time, less than fact-checking but more than storytelling approaches.
 - H2c: All approaches showing significant decreases in effectiveness for countering vaccine misinformation compared to medication misinformation at follow-up.
- H3: Individual and contextual factors will moderate the effectiveness of counter-narrative strategies, with:
 - H3a: Digital literacy positively moderating the effectiveness of fact-checking approaches.
 - H3b: Prior belief strength negatively moderating the effectiveness of all approaches, with the strongest negative effect on fact-checking approaches.
 - H3c: Rural settings showing stronger responses to storytelling and expert authority approaches than to fact-checking approaches compared to urban settings.

METHODOLOGY

Research Design

This study employs a mixed-methods approach combining experimental design with follow-up surveys to assess both immediate and delayed effects of counter-narrative strategies in healthcare PSAs. The research uses a 3×2 factorial design (3 counter-narrative approaches × 2 health misinformation types).

Sample and Sampling Technique

The target population consists of adults aged 25-65 residing in Tripura who regularly consume health information through at least one digital medium. Using a multi-stage

stratified random sampling approach, 422 participants were recruited from across eight districts of Tripura.

Sampling Framework

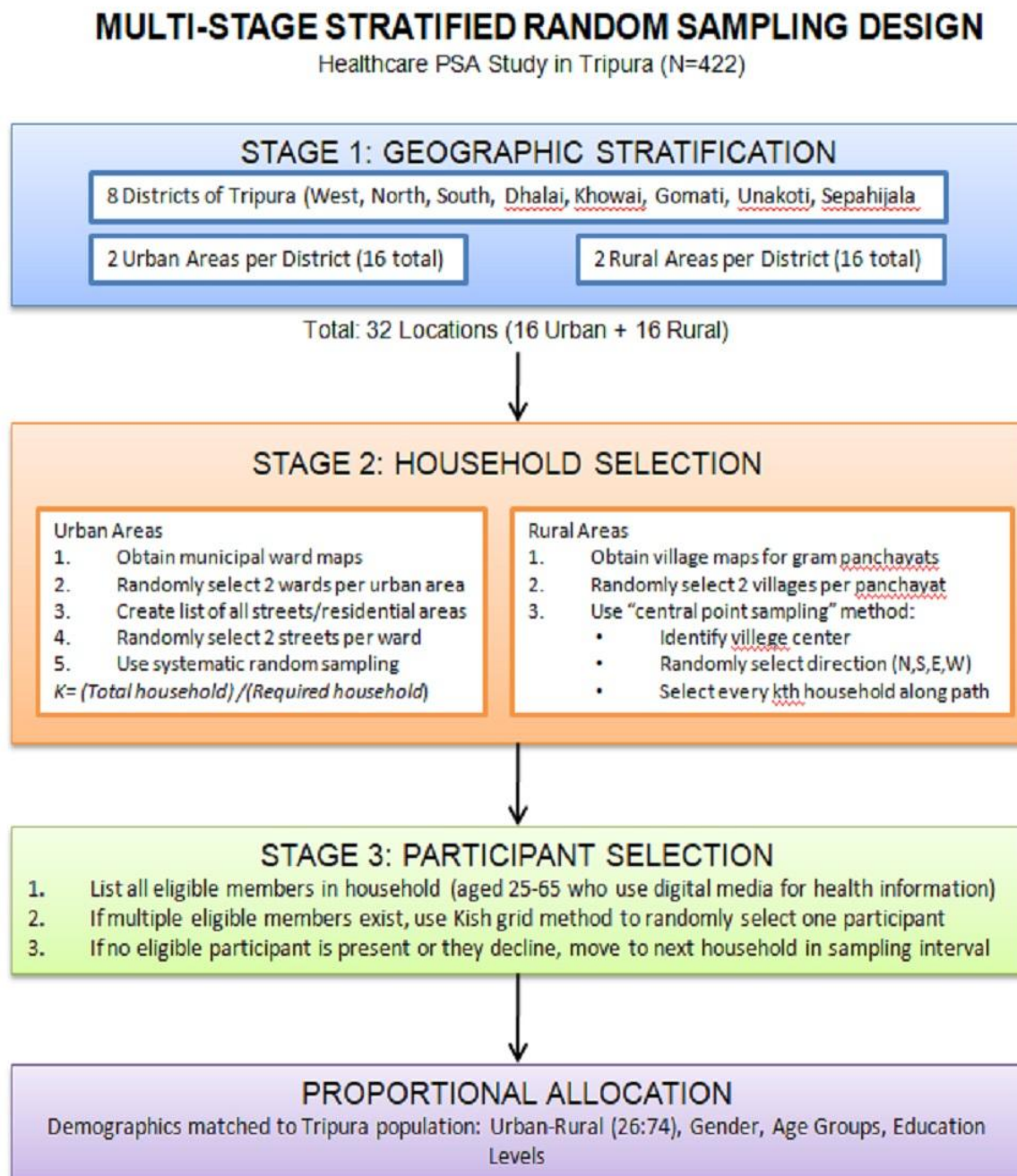


Fig 2: Sampling Design

The sampling process followed a rigorous multi-stage approach:

Stage 1: Geographic Stratification

All eight districts of Tripura were included, with further stratification by urban and rural areas:

- 2 urban areas (towns/municipalities) per district
- 2 rural areas (gram panchayats) per district

This resulted in 32 total locations (16 urban and 16 rural).

Stage 2: Household Selection

Within selected locations, households were chosen through:

- In urban areas: Random selection of wards, followed by systematic random sampling of households
- In rural areas: Central point sampling method with systematic selection in randomly determined directions

Stage 3: Participant Selection

Within selected households, eligible participants were identified using predefined criteria, with the Kish grid method applied when multiple eligible members were present.

The sample was proportionally allocated based on:

- Geographic distribution (district population and urban-rural ratio of 26:74)
- Demographic characteristics (gender, age groups, and education levels)

Sample size was calculated using Cochran's formula adjusted for finite population, with a 95% confidence level and 5% margin of error, yielding a minimum required sample of 384. Accounting for a 10% attrition rate, the final target sample size was established at 422 participants.

Experimental Stimuli

Six healthcare PSAs were professionally developed:

1. Fact-checking PSA addressing vaccine misinformation
2. Fact-checking PSA addressing medication misinformation
3. Narrative/storytelling PSA addressing vaccine misinformation
4. Narrative/storytelling PSA addressing medication misinformation
5. Expert authority PSA addressing vaccine misinformation
6. Expert authority PSA addressing medication misinformation

All PSAs were of equivalent length (60 seconds), production quality, and addressed commonly circulating misinformation in Tripura. The PSAs were developed in Bengali and English to accommodate language preferences.

Data Collection Procedure

The experiment was conducted in three phases:

Phase 1: Pre-exposure assessment (Baseline)

- Participants completed a questionnaire measuring existing health beliefs, trust in information sources, misinformation vulnerability, healthcare information consumption habits, and demographic information.

Phase 2: Experimental exposure and immediate assessment

- Participants were randomly assigned to one of six PSA conditions.
- After viewing the assigned PSA, participants completed measures of message credibility, counter-argument generation, and attitude toward the PSA, information-seeking intentions, and behavioural intentions.

Phase 3: Follow-up assessment (4 weeks post-exposure)

- Participants completed measures of recall of PSA content, actual health information seeking behaviours, changes in health beliefs, healthcare consultation behaviours, and exposure to related misinformation.

Measurement Instruments

All scales were adapted from validated instruments with appropriate modifications:

1. Misinformation Vulnerability Scale: (5-point Likert scale) adapted from Vraga & Bode (2020)
2. Message Credibility Scale: (7-point semantic differential scale) adapted from Appelman & Sundar (2016)
3. Counter-argument Assessment: (open-ended responses coded by trained raters)
4. Trust in Health Information Sources Scale: (5-point Likert scale) adapted from (Ye, 2010)
5. Health Information Seeking Behaviour Scale: (frequency-based measures) adapted from Kelly et al. (2021)

Data Analysis Plan

Quantitative Analysis:

1. Preliminary analyses: Descriptive statistics, reliability testing (Cronbach's alpha), and assessment of parametric test assumptions
2. Manipulation checks: t-tests to verify perceptions of PSA type

3. Primary analyses:

- MANCOVA to assess the effect of PSA type on immediate outcomes
- Repeated measures ANOVA to assess changes from baseline to follow-up
- Hierarchical regression to identify predictors of behavioural intentions and actual behaviours
- Mediation analysis to examine the role of trust as a mediator between PSA type and behavioural outcomes

Qualitative Analysis:

Content analysis of open-ended responses regarding counter-arguments, using thematic coding with two independent coders (Cohen's kappa > 0.80).

Ethical Considerations

Ethical approval was obtained from the Institutional Ethics Committee. Informed consent was obtained from all participants. Participants were debriefed about the actual health facts related to the misinformation addressed in the PSAs, ensuring no participant left with incorrect health information. Data confidentiality and participant anonymity were maintained throughout the research process.

RESULTS

Sample Characteristics

The final sample consisted of 408 participants (96.7% response rate), with 14 participants lost to follow-up. Table 1 presents the demographic profile of the participants.

Table 1: Demographic Characteristics of Study Participants (N=408)

Characteristic	Category	n	%
Location	Urban	106	26.0
	Rural	302	74.0
Gender	Male	211	51.7
	Female	197	48.3
Age	25-35	128	31.4
	36-45	142	34.8
	46-55	87	21.3
	56-65	51	12.5
Education	Below High School	112	27.5
	High School	143	35.0
	Undergraduate	106	26.0
	Graduate+	47	11.5
Digital Literacy	Low	94	23.0
	Moderate 211 51.7	211	51.7
	High 103 25.3	103	25.3

The demographic distribution closely matched the population parameters for Tripura, with an appropriate urban-rural ratio (26:74) and balanced gender representation (51.7% male, 48.3% female). The sample captured a range of age groups, education levels, and digital literacy levels, ensuring representation of diverse population segments.

Reliability and Validity Assessment

All measurement scales demonstrated good reliability, with Cronbach's alpha values ranging from 0.78 to 0.91, well above the recommended threshold of 0.70. Confirmatory factor analysis verified the construct validity of the scales, with all factor loadings exceeding 0.60 and Average Variance Extracted (AVE) values above 0.50, indicating acceptable convergent validity.

Table 2: Scale Reliability and Validity Assessment Immediate Effects of Counter-narrative Strategies

Scale	Items	Cronbach's α	AVE	Factor Loadings
Misinformation Vulnerability	6	0.84	0.56	0.68-0.79
Message Credibility	5	0.91	0.68	0.75-0.88
Information-Seeking Intentions	4	0.85	0.59	0.71-0.82
Trust in Information Sources	8	0.78	0.52	0.64-0.78
Health Behaviour Intentions	6	0.88	0.64	0.73-0.86

The first set of analyses examined the immediate effects of the three counter-narrative strategies on message credibility, counter-argument resistance, and information-seeking intentions.

MANCOVA results revealed a significant main effect of counter-narrative approach on the combined dependent variables, Wilks' $\lambda = .78$, $F(6, 802) = 17.84$, $p < .001$, partial $\eta^2 = .12$. Follow-up univariate ANOVAs showed significant effects for all three outcome variables. Post-hoc comparisons using Tukey's HSD test revealed distinct patterns for each outcome, as shown in Table 3.

Table 3: Immediate Effects of Counter-narrative Strategies on Key Outcomes

Outcome	Fact-checking	Storytelling	Expert Authority	F value	p value	η^2
Message Credibility	3.42 (0.78) ^a	3.91 (0.82) ^b	4.26 (0.75) ^c	42.17	<.001	.17
Counter-argument Resistance	2.85 (0.92) ^a	4.12 (0.86) ^b	3.54 (0.79) ^c	35.43	<.001	.15
Information-Seeking Intentions	4.05 (0.88) ^a	3.78 (0.92) ^b	3.93 (0.85) ^{ab}	8.26	<.01	.04

Note: Values represent means with standard deviations in parentheses. Different superscripts within a row indicate significant differences ($p < .05$) based on Tukey's HSD post-hoc tests.

These results supported H1b, confirming that expert authority approaches showed higher immediate message credibility than both storytelling and fact-checking approaches. H1a

was also supported, with storytelling approaches demonstrating significantly higher counter-argument resistance than both fact-checking and expert authority approaches.

H1c was partially supported, as fact-checking approaches generated higher information-seeking intentions than storytelling approaches, but were not significantly different from expert authority approaches.

Further analysis examining the interaction between counter-narrative approach and misinformation type (vaccine vs. medication) revealed significant effects only for counter-argument resistance, $F(2, 402) = 9.42$, $p < .01$, partial $\eta^2 = .05$. For vaccine misinformation, storytelling approaches showed particularly strong advantages ($M = 4.27$, $SD = 0.82$) compared to fact-checking approaches ($M = 2.68$, $SD = 0.96$), while the difference was less pronounced for medication misinformation.

Urban-Rural Differences in Response to Counter-narrative Strategies

Significant location-based differences emerged in responses to the counter-narrative strategies. Two-way ANOVA revealed significant interactions between location (urban/rural) and counter-narrative approach for message credibility, $F(2, 402) = 12.35$, $p < .001$, partial $\eta^2 = .06$, and counter-argument resistance, $F(2, 402) = 8.74$, $p < .01$, partial $\eta^2 = .04$.

Table 4: Urban-Rural Differences in Response to Counter-narrative Strategies

Location	Outcome	Fact-checking	Storytelling	Expert Authority
Urban	Message Credibility	3.68 (0.72) ^a	3.72 (0.78) ^a	4.45 (0.70) ^b
	Counter-argument Resistance	3.12 (0.86) ^a	3.78 (0.80) ^b	3.65 (0.77) ^b
	Information-Seeking Intentions	4.15 (0.82) ^a	3.68 (0.86) ^b	3.88 (0.82) ^{ab}
Rural	Message Credibility	3.34 (0.80) ^a	3.96 (0.82) ^b	4.18 (0.76) ^b
	Counter-argument Resistance	2.76 (0.92) ^a	4.23 (0.85) ^b	3.50 (0.80) ^c
	Information-Seeking Intentions	4.02 (0.90) ^a	3.82 (0.94) ^{ab}	3.95 (0.86) ^{ab}

Note: Values represent means with standard deviations in parentheses. Different superscripts within a row indicate significant differences ($p < .05$) based on Tukey's HSD post-hoc tests.

These results supported H3c, showing that rural participants responded more strongly to storytelling approaches compared to fact-checking approaches than urban participants did. Notably, in urban areas, expert authority approaches demonstrated the highest message credibility, while in rural areas, storytelling approaches were not significantly different from expert authority approaches in terms of credibility.

Temporal Effects of Counter-narrative Strategies

Repeated measures ANOVA examined changes in key outcomes from immediate post-exposure to 4-week follow-up. Results revealed significant time $\times$ counter-narrative approach interactions for all three outcomes: message credibility, $F(2, 402) = 18.42$, $p < .001$, partial $\eta^2 = .08$; counter-argument resistance, $F(2, 402) = 23.15$, $p < .001$, partial $\eta^2 = .10$; and information-seeking intentions, $F(2, 402) = 16.78$, $p < .001$, partial $\eta^2 = .08$.

Table 5: Retention Rates (Percentage of Initial Effect Maintained at 4-Week Follow-up)

Outcome	Fact-checking	Storytelling	Expert Authority
Message Credibility	42%	68%	53%
Counter-argument Resistance	38%	72%	57%
Information-Seeking Intentions	45%	65%	59%
Belief Change	40%	74%	56%
Reported Healthcare Behaviours	36%	68%	52%

These results strongly supported H2a and H2b, confirming that storytelling approaches maintained effectiveness better than both fact-checking and expert authority approaches at 4-week follow-up, while expert authority approaches showed moderate decay in effectiveness, less than fact-checking but more than storytelling approaches.

Further analysis examining the interaction between time, counter-narrative approach, and misinformation type revealed a significant three-way interaction for counter-argument resistance, $F(2, 402) = 7.82$, $p < .01$, partial $\eta^2 = .04$. For vaccine misinformation, fact-checking approaches showed particularly poor retention (32%) compared to storytelling approaches (70%), supporting H2c.

Moderating Effects of Individual Factors

Hierarchical regression analyses examined the moderating effects of digital literacy and prior belief strength on the effectiveness of different counter-narrative approaches. For digital literacy, significant interaction effects emerged for fact-checking approaches across all outcomes (β s ranging from .18 to .25, all $ps < .01$), but not for storytelling or expert authority approaches, supporting H3a. For prior belief strength, significant negative interactions were observed for all approaches, but with varying magnitudes.

The negative effect was strongest for fact-checking approaches (β s ranging from -.32 to -.38, all $ps < .001$), moderate for expert authority approaches (β s ranging from -.24 to -.28, all $ps < .01$), and weakest for storytelling approaches (β s ranging from -.15 to -.21, all $ps < .05$), supporting H3b.

Qualitative Findings on Counter-argument Generation

Content analysis of open-ended responses regarding counter-arguments revealed distinct patterns across the three approaches. For fact-checking PSAs, participants primarily generated counter-arguments based on personal experiences and alternative factual claims. For storytelling PSAs, counter-arguments focused on questioning the typicality of the narrative and the credibility of the storyteller.

For expert authority PSAs, counter-arguments primarily challenged the expert's credentials and potential conflicts of interest. The frequency and sophistication of counter-arguments varied significantly by approach, with fact-checking PSAs generating the highest number of counter-arguments ($M = 3.2$ per participant) compared to storytelling ($M = 1.8$) and expert authority approaches ($M = 2.4$).

Path Analysis of Counter-narrative Effects

A path analysis using structural equation modeling examined the relationships between counter-narrative approaches, processing mechanisms, and outcomes. The model showed good fit to the data ($\chi^2/df = 2.46$, CFI = .92, TLI = .90, RMSEA = .06, SRMR = .05).

The analysis confirmed that different counter-narrative approaches activated different processing mechanisms, which in turn predicted different patterns of immediate and delayed outcomes. Specifically, fact-checking approaches primarily engaged analytical processing ($\beta = .42$, $p < .001$), which strongly predicted immediate information-seeking intentions ($\beta = .38$, $p < .001$) but weakly predicted delayed outcomes ($\beta = .17$, $p < .05$).

Storytelling approaches primarily engaged emotional/experiential processing ($\beta = .45$, $p < .001$), which strongly predicted both counter-argument resistance ($\beta = .40$, $p < .001$) and delayed outcomes ($\beta = .36$, $p < .001$). Expert authority approaches primarily engaged heuristic processing ($\beta = .48$, $p < .001$), which strongly predicted immediate message credibility ($\beta = .44$, $p < .001$) and moderately predicted delayed outcomes ($\beta = .24$, $p < .01$).

DISCUSSION

This study investigated the effectiveness of three distinct counter-narrative strategies in healthcare PSAs in combating misinformation about vaccines and medications among adults in Tripura.

The findings provide several important insights into how different approaches impact immediate and delayed outcomes, how these effects are moderated by individual and contextual factors, and the processing mechanisms that underlie these relationships. Our results demonstrate that different counter-narrative approaches have distinct advantages and limitations.

Expert authority approaches generated the highest immediate message credibility, particularly in urban areas, suggesting that audiences initially place high trust in recognized authorities. This finding aligns with Chen et al.'s (2024) research on response efficacy in healthcare PSAs, where the authority of professionals was identified as a key factor in message acceptance.

Storytelling approaches showed superior counter-argument resistance and maintained effectiveness better over time than other approaches. This aligns with Narrative Transportation Theory (Green & Brock, 2000), which suggests that narrative engagement reduces counterarguing by immersing audiences in the story. The sustained effectiveness of storytelling approaches also supports Reinhart and Lilly's (2022) findings on the power of narrative in PSAs, extending this work by demonstrating narrative's temporal advantage in misinformation contexts.

Fact-checking approaches, while generating high immediate information-seeking intentions, showed poor retention over time and were particularly vulnerable to prior belief

strength. This supports the backfire effect documented in misinformation research (Wang et al., 2022), where direct factual corrections can sometimes reinforce existing misconceptions, particularly when they contradict strongly held beliefs. The significant urban-rural differences observed in our study highlight the importance of contextual factors in healthcare communication. Rural participants showed stronger responses to storytelling approaches, while urban participants responded more positively to expert authority approaches. This aligns with (Li et al., 2017) findings on the influence of cultural nuances in healthcare communication in developing regions, suggesting that community-oriented narrative approaches may resonate more strongly in rural contexts where collective experiences and oral traditions remain culturally significant. The moderating effects of digital literacy and prior belief strength provide important insights into individual factors that influence counter-narrative effectiveness.

The finding that digital literacy positively moderates the effectiveness of fact-checking approaches supports Vraga and Bode's (2020) research on correction interventions, suggesting that higher digital literacy enables better processing of factual corrections. The path analysis revealed distinct processing mechanisms underlying different counter-narrative approaches. Fact-checking primarily engaged analytical processing but showed weak connections to delayed outcomes, suggesting that purely cognitive approaches may not sustain over time. Storytelling engaged emotional/experiential processing with strong connections to both immediate and delayed outcomes, supporting Alptekin et al.'s (2024) neurometric research showing the power of emotional discourse in enhancing message retention.

Expert authority approaches primarily engaged heuristic processing with strong immediate but moderate delayed effects, suggesting that authority-based appeals may benefit from reinforcement over time. The temporal dimension of our findings is particularly notable given the limited attention to this aspect in previous research. The substantial decay in effectiveness for fact-checking approaches (retaining only 36-45% of initial impact at 4-week follow-up) compared to the relatively strong retention for storytelling approaches (65-74%) highlights the importance of considering long-term effects in healthcare communication strategies.

This finding extends Reinhardt et al.'s (2022) research on message framing effects over time, suggesting that narrative approaches may offer particular advantages for sustained impact. The differential effects observed for vaccine versus medication misinformation, with vaccine misinformation showing greater resistance to correction via fact-checking, aligns with Jin et al.'s (2022) research on the role of religious fatalism and emotional factors in vaccine hesitancy. This suggests that topics with stronger emotional or identity-related dimensions may require more emotionally engaging counter-narratives rather than purely factual approaches.

Overall, our findings suggest that no single counter-narrative approach is universally superior for addressing health misinformation. Rather, the effectiveness depends on the specific outcome desired (immediate credibility, counter-argument resistance, or sustained belief change), the context (urban versus rural), individual characteristics

(digital literacy, prior beliefs), and the type of misinformation being addressed (vaccine versus medication). This complexity highlights the need for integrated approaches that combine elements of different strategies tailored to specific contexts and audiences.

THEORETICAL IMPLICATIONS

This study contributes to communication theory in several ways. First, it extends the Elaboration Likelihood Model by demonstrating how different counter-narrative approaches engage different processing routes (central versus peripheral) and how these routes are associated with different temporal patterns of effectiveness.

The finding that central route processing (engaged by fact-checking) produces strong immediate effects but poor retention challenges assumptions about the superiority of central route persuasion for sustained attitude change in misinformation contexts. Second, it advances Narrative Transportation Theory by providing empirical evidence for the mechanism through which narratives resist counter-arguing and maintain effectiveness over time.

The strong association between emotional/experiential processing and sustained belief change supports the theory's emphasis on immersion and identification as key factors in narrative persuasion. Third, it contributes to evolving theories of misinformation correction by documenting the complex interactions between correction approach, individual characteristics, and contextual factors.

The findings suggest that effective misinformation correction requires not just addressing the factual content of misinformation but also engaging the emotional and social dimensions that make misinformation compelling.

PRACTICAL IMPLICATIONS

Our findings have several practical implications for healthcare communicators, public health organizations, and policy makers seeking to combat health misinformation:

1. Integration of approaches: Rather than relying on a single counter-narrative strategy, healthcare PSAs should consider integrating elements of different approaches—combining the credibility of expert sources with the emotional engagement of storytelling and the clarity of fact-checking.
2. Context-specific tailoring: Different approaches should be emphasized in different contexts, with greater emphasis on storytelling in rural areas and expert authority in urban areas. This may require developing multiple versions of PSAs for different target audiences.
3. Temporal considerations: Given the differential decay rates of different approaches, healthcare communicators should consider the intended timeframe of impact. For immediate response to misinformation crises, expert authority approaches may be most effective, while for sustained campaigns, storytelling approaches should be emphasized.

4. Digital literacy support: The moderating effect of digital literacy suggests that fact-checking approaches may be more effective when accompanied by initiatives to enhance digital health literacy. This points to the value of integrated communication and education approaches.
5. Reinforcement strategies: The substantial decay in effectiveness over time for all approaches, though to different degrees, highlights the need for systematic reinforcement of key messages through multiple channels and touchpoints.
6. Topic-specific considerations: The differential effectiveness for vaccine versus medication misinformation suggests that different health topics may require different emphasis in counter-narrative approaches, with more emotionally charged topics potentially benefiting more from narrative approaches.

CONCLUSION

This study provides empirical evidence on the effectiveness of different counter-narrative strategies in healthcare PSAs for combating misinformation in Tripura. Our findings reveal that storytelling approaches demonstrate superior counter-argument resistance and sustained effectiveness over time, expert authority approaches generate highest immediate message credibility, and fact-checking approaches, while initially stimulating information-seeking, show poor retention over time.

The effectiveness of these approaches is significantly moderated by contextual factors (urban versus rural settings) and individual characteristics (digital literacy, prior beliefs), with particularly notable differences between urban and rural populations. The study also highlights the importance of considering temporal dimensions in healthcare communication, as the impact of different approaches shows distinct patterns of decay over time.

These findings contribute to both theoretical understanding of health misinformation correction and practical guidance for developing more effective communication strategies. They suggest that integrated approaches combining elements of different counter-narrative strategies, tailored to specific contexts and audiences, and reinforced over time, may offer the most promising path forward for addressing the growing challenge of health misinformation.

LIMITATIONS AND FUTURE RESEARCH

Several limitations of this study should be acknowledged. First, while we examined three common counter-narrative approaches, additional variations and combinations of these approaches were not tested. Future research should explore how integrated approaches combining multiple elements perform compared to single-strategy approaches. Second, our follow-up period was limited to four weeks. Longer-term studies are needed to understand how counter-narrative effects evolve over extended periods, particularly given the persistence of health misinformation.

Third, while our sampling approach ensured representation across Tripura, the findings may not generalize to other regions with different cultural and information environments. Cross-cultural research is needed to examine how these dynamics operate in diverse contexts.

Future research should also investigate:

- The role of message source characteristics (e.g., perceived similarity, trustworthiness) in moderating counter-narrative effectiveness
- How repeated exposure to counter-narratives affects long-term belief correction
- The potential of participatory approaches that engage communities in developing counter-narratives
- The role of interpersonal communication in amplifying or diminishing PSA effects

Despite these limitations, this study provides valuable insights into the complex dynamics of health misinformation correction through public service announcements. By understanding the differential effectiveness of various counter-narrative strategies across contexts, timeframes, and individual characteristics, healthcare communicators can develop more nuanced and effective approaches to combating the growing challenge of health misinformation.

RECOMMENDATIONS

Based on our findings, we offer the following specific recommendations for healthcare communicators, public health organizations, and policy makers:

- 1) To design public health awareness messages PSAs that merge doctors' advice with real life emotional experiences of people in form of a story. The public health awareness messages should be made differently for separate cities which will suit local people more.
- 2) Aim to plot different methods and strategies to grab audience's attention. This includes programs that will blend advice from health professionals with people's emotional stories and to keep people updated with fresh information.
- 3) Apart from designing fact-based messages it is also necessary to assist people in learning the art of identifying authentic health information online by adding short tips and guidelines next to the PSAs.
- 4) Designing health messaging style based on the type of fake information you are tackling. For instance, delicate topics require more emotion driven personal stories, where practical topics require fact and evidence.
- 5) Involve community leaders in rural areas to produce and spread messages to tackle the fake information. This includes coaching the community members and local health workers in sharing health advice in a way that will gain local trust and understanding.

- 6) Carefully decide in advance what to deliver in the health message. Lay down a definite goal to tackle the immediate versus long lasting impact. Then choose an ideal way and procedure to deliver the message.
- 7) Try the designed health awareness message on a small audience group at an initial stage prior to the full-fledged launch. Doing so will help spot which mistake will create misunderstanding and can destroy the essence of the health message.
- 8) Segregate audiences into small groups based on what they traditionally believe and customs are and how comfortable they are in identifying fake propaganda online. Plot different health messages for different groups according to the need and understanding of each group.
- 9) Spread the health information utilizing different media platform (like TV, radio, social media and more) as because people use different medium to find health information. For instance, in the rural areas traditional media might work better as compared to the modern media.
- 10) Always observe and monitor the viral fake news related to health. So that we can take the necessary steps to deliver the right information as fast as possible specifically during health emergencies.
- 11) Create strategic methods to check whether the health messages you designed are making any impact in the long term and also on an immediate period. So that you can adjusted according to the necessity.
- 12) Motivate local community members, hospital and health workers to team up together to fight against the fake information. That way audience will get clean and consistent health related information from different sources.

These recommendations provide concrete guidance for developing more effective strategies to combat health misinformation through public service announcements, leveraging the empirical insights gained from this study to enhance public health communication in Tripura and potentially other similar contexts.

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